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POLYDORA NARICA, NEW SPECIES, AND *PSEUDOPOLYDORA KEMPI CALIFORNICA*, NEW SUBSPECIES, TWO NEW SPIONIDS (ANNELIDA: POLYCHAETA) FROM CENTRAL CALIFORNIA

By

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Abstract: A new species and a new subspecies of spionoform polychaetous annelids have been added to the fauna of central California. *Polydora narica* is a generalized member of the "*ciliata*" group and shows affinities with several other polydorid species complexes, as well. *Pseudopolydora kempi californica* constitutes a second locality record for *Pseudopolydora kempi* (Southern) in the eastern Pacific. It is much more closely related to the Indian than to the Japanese subspecies.

Introduction

One slightly damaged specimen of a new species of *Polydora* was collected at a depth of between 100 and 200 feet off San Jose Creek Beach (Monastery Beach), Carmel, Monterey County, California by Dennis Sullivan of the California Academy of Sciences in August, 1962. The specimen came from a sample containing several individuals of an as yet unidentified ampharetid, and it may have been living commensally in the tubes of the latter species.

In August, 1967, Dr. Joel F. Gustafson, San Francisco State College, collected three specimens of a variety of *Pseudopolydora kempi* (Southern) from separate stations at the north end of Bolinas Lagoon, Marin County, California. This is the third time and the second locality from which the stem species has been cited in the eastern Pacific. It was previously reported from Morro Bay, California by Blake (1966, p. 182) and Reish and Barnard (1967, p. 10), and

it is otherwise known from India, Japan, the Kurile Islands, the Korean Archipelago, and South Africa. A new subspecies is herein designated.

Family Spionidae Grube, 1850

Genus **Polydora** Bosc, 1802

Polydora narica Light, new species.
(Figures 1–8.)

Diagnosis. Possession of a well developed and densely papillated, extrusible proboscis. Modified major spines of the fifth setiger simple, heavy, and semifalcate, with a subterminal lateral accessory tooth on the ventral side, from which a flange runs posterodorsally, forming a hoodlike cowl over the spatulate posterior surface of the main shaft. Up to 17 simple, hooded, neuropodial hooks or crotchets in a single series per segment, continuing to the last pre-pygidial segment, with the beak forming an acute angle with the main shaft. Prostomial caruncle greatly elongated and swollen posteriorly, extending to the anterior border of the modified fifth segment. Notosetae of the anterior (pre-fifth) segments greatly elongate and extending in close fascicles beyond the posterior border of the following somite in an imbricate fashion. Mid-portion of body laterally constricted; caudal region sharply attenuated with reduced pygidium.

Description of holotype. The length is about 11.5 mm. over some 86 segments (the exact number is not clear because of the poor condition of some of the median and posterior somites); the width is less than 1 mm. and the worm is laterally constricted in the middle of the body, the anterior and posterior regions being noticeably wider. The animal is distinctly compressed dorsoventrally in the first third of its length and the vertical sides of the somites form sharply rounded right angles with the dorsal and ventral surfaces, giving the appearance of a broad low rectangle in cross section. The ventrum is somewhat convex and the dorsum nearly flat; the latter exhibits a clearly defined, narrow, median groove which disappears in the middle and posterior segments. The anterior notosetae and, somewhat more posteriorly, the branchiae, stand erect from the lateral edge of the dorsum, giving the anterior portion of the animal a deeply depressed or concave appearance. The dorsum is already rising in a convexly rounded hump by somite 17, and the dorsal median groove is no longer in evidence. Further back the dorsal surface is quite high and broadly rounded

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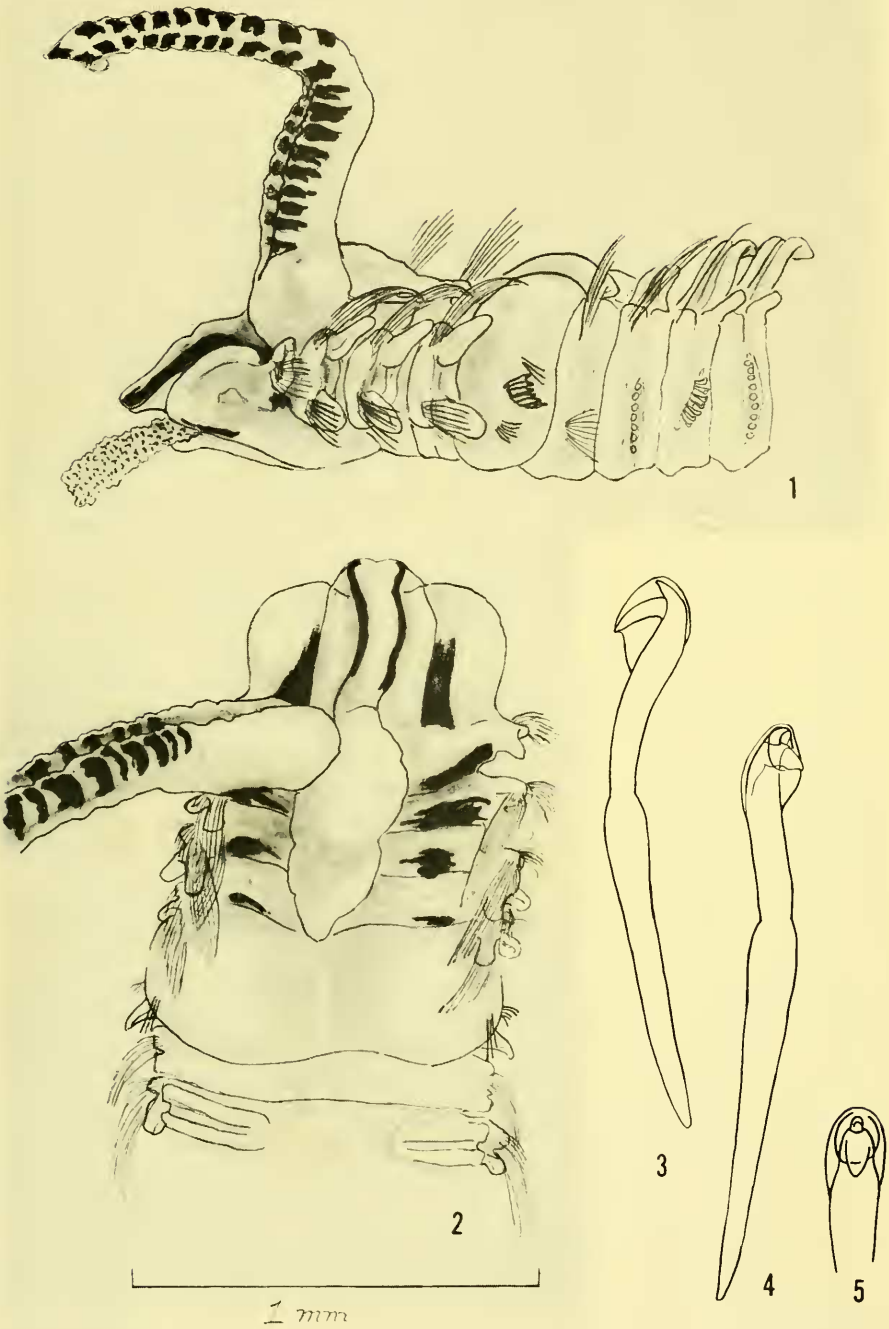
Figure 1. *Polydora narica*, new species. Anterior end, left lateral view, showing everted proboscis. × 56.

Figure 2. *Polydora narica*, new species. Anterior end, dorsal view, right palp removed. × 56.

Figures 3, 4, and 5. *Polydora narica*, new species. Hooded neuropodial crotchets: lateral, three-quarter, and frontal aspects. × 390.


1
2
3
4
5
1 mm

and forms a continuous, broad, inverted "U" with the sides of the body; the sharp angle between the ventrum and the sides, however, is still maintained. Far posteriorly, the dorsum again becomes more or less flattened and the caudal region is sharply attenuated laterally and terminates in a blunt, cuplike pygidium.

Prostomium. The prostomium is elongated anteriorly well beyond the anterior border of the peristomial lateral cephalic lobes (figs. 1 and 2). Superficially, it resembles that of *Boccardia probosidea* Hartman (1940, fig. 1-a, b, d),[1] but differs in being faintly notched anteriorly. In the holotype, the prostomium is bent to one side when viewed from above, but this may be the result of preservation. It consists of a high, narrow, median ridge that becomes abruptly wider and higher as it passes into the caruncle at the level of insertion of the palpi, to almost twice its anterior width and depth, forming a prominent boss or dome. From this point, it tapers somewhat unevenly to the anterior border of setiger 5, where it terminates in a blunt rounded end. When viewed from the side, the large dorsal hump of the caruncle slopes sharply downward from setiger 3 to the fifth. It reaches its apex at about the posterior border of the palpi, but there is no trace of an occipital tentacle or cirrus. Prostomial eyes are likewise not evident. The prostomial ridge is mounted atop a laterally extended sheetlike membrane which slopes slightly downward on each side of the ridge. It extends laterally not quite to the mid-line of the lateral cephalic lobes and its border runs longitudinally from the base of the palpi to the anterior tip of the prostomium. It lies just medial to a similarly oriented, dark peristomial stripe running for most of the length of the cephalic lobes. This membrane forms a webbing or a weblike cowl between the anterior end of the prostomial ridge and the anteromedial border of the cephalic lobes. A conspicuous, sooty brown stripe runs longitudinally down either side of the prostomial ridge at its juncture with the prostomio–peristomial membrane just described, and barely extends onto the anterior margin of the prostomium, making the latter a sharply prominent feature.

Peristomium. The peristomium forms a pair of widely flaring and prominent lateral cephalic lobes, each of which is just over twice as wide as the prostomial ridge. Medially, they lie ventral to the prostomio–peristomial membrane. They are compressed dorsoventrally and extend dorsally back to the base of the palpi, where they are fused with the first parapodium. Ventrally, they sweep down past the U-shaped buccal opening and form a long, prominent, V-shaped ridge on both sides which more or less closes below the level of the second parapodia. Posteriorly, the peristomium continues back to the level of the third and fourth parapodia, considerably crowding somites two and three, ventrally (fig. 1).

The proboscis, which was originally extended (it retracted back into the

[1] See also Imajima and Hartman, 1964. Part II. Plate 36a, p. 425.

buccal cavity upon removal of part of the fifth setiger for further examination), is densely papillated with many, minute, pear-shaped, and cirriform tubercles. The presence of an eversible and well differentiated proboscis is a highly unusual feature in this genus.

Coloration. The dark-brown, sooty pigmentation (figs. 1 and 2) is very much like that shown for *Polydora ciliata* (Johnston, 1838) by Carazzi (1895, table 2, fig. 4). That of the prostomial ridge has already been mentioned; the lateral stripe passes around to the anterior border of the prostomial ridge, but does not join its companion at the midpoint, and the ventral surface of the prostomium is conspicuously white. A dark, somewhat triangular patch, with its apex oriented anteriorly and merging into a line (briefly described in connection with the prostomio–peristomial membrane) running forward for more than half the length of the cephalic lobe is situated at the base of the palpi on both sides medially between the prostomial ridge and the lateral edges of the peristomium. This line borders the lateral margin of the prostomio–peristomial membrane (fig. 2). There is a pair of elongate, more or less crescent-shaped markings bordering either side of the buccal opening, ventrally, and two smaller, less distinct blotches at the base of the first neuropodium between segments one and two.

The palpi are moderately long and thick, extending back to about the eleventh or twelfth segments, and the deep tentacular grooves are situated anteriorly along their lengths. There are from 26 to 28 irregularly rectangular blotches running transversely around both sides of each palp from the groove to a point about two-thirds of the way to the trailing edge of the palp. The blotches are widest toward the groove and are at first somewhat faint, becoming wider and more prominent distally, until they form approximately squarish blots.

A dark line extends laterally along the posterior borders of the first four segments. These lines are most pronounced on the first two somites, where they extend to the bases of the parapodia; those of the following two somites are smaller and more diffuse, with a somewhat teardrop-shaped distal expansion.

Modified fifth setiger. The modified fifth segment is fully 2½ times as long as the adjacent segments; the unmodified segments, with the exception of the sixth, which is dorsally somewhat reduced, are about 6½ times as wide as they are long.

Segment 5 bears five heavy modified adult spines (fig. 7) which have been partially described above, and four embryonic spines which strongly resemble the adult spines of *P. ciliata* (Johnston). The adult spines project laterally in a steep anterodorsally–posteroventrally sweeping arc, which is situated at the posterior end about halfway up the side of the segment. They are larger and more rugose anteriorly and form heavy spikelike shafts when fully developed. They have a blunt, posteriorly depressed, falcate tip which forms a concave surface and a smaller lateral accessory tooth which arises on the ventral side of the main

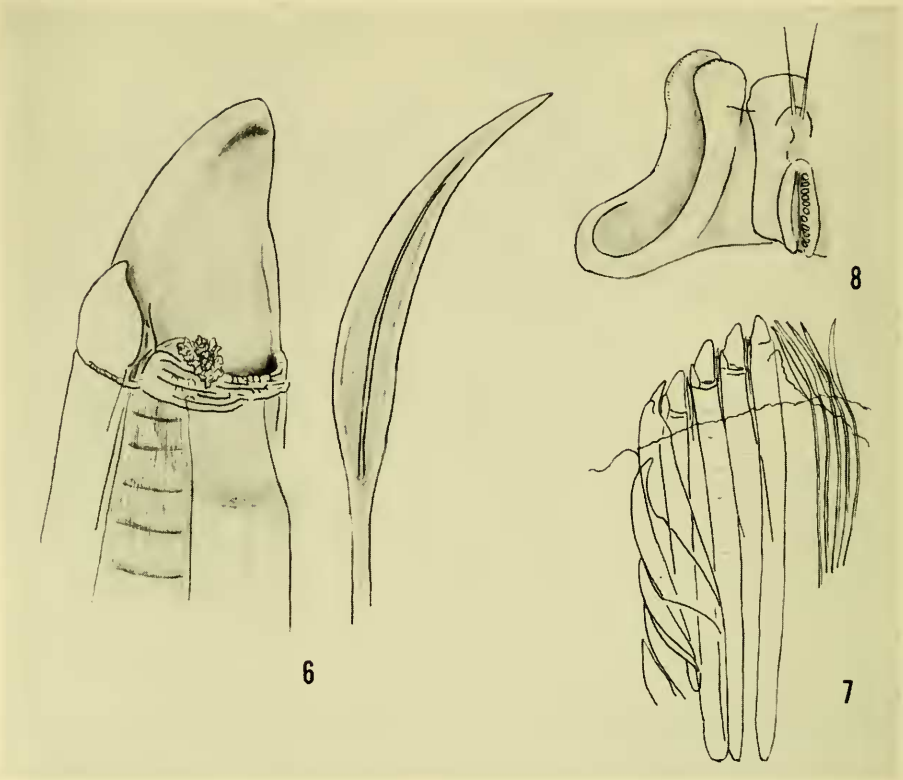


Figure 6. *Polydora narica*, new species. Major modified spine and companion seta from fifth setiger. × 600.

Figure 7. *Polydora narica*, new species. Major modified spine series of fifth setiger, showing embryonic and adult spines. × 75.

Figure 8. *Polydora narica*, new species. Pygidium, lateral view of right side. × 56.

shaft to one side of the posterior distal concavity, much as in *P. ciliata*. These spines differ from those of *P. ciliata* and of almost all other species in possessing a liplike flange which runs from the neighborhood of the base of the accessory tooth to the opposite side of the main shaft (fig. 6), forming a hooded cowl over the medial half of the concave surface of the main shaft. In this feature, these spines resemble those of *P. colonia* Moore (1907, p. 200, plate XV, figs. 20a, 21). The core of the main shaft bends posteriorly in the region of the hooded flange in an inverted "J," and the tip of this J forms a disorganized mass of highly refractile tissue which protrudes from beneath the flange in the proximity of the lateral accessory tooth. This core is longitudinally striated and there are a series of transverse bands or ridges which may represent lines of growth. These spikes are quite long and medially expanded, especially the embedded embryonic ones,

and they do not protrude very much from the parapodial tissue (fig. 7). It is extremely difficult to visualize the structure of these spikes, and a careful examination of the various stages of their development is necessary in order to determine their correct configuration.

As has already been indicated, the most anterior spikes are the largest and most eroded, having somewhat truncated tips. They decrease regularly in size posteriorly, the ends becoming sharper and more pointed and the accessory tooth and flange less pronounced. They are amber colored and under low magnification the accessory teeth and their flanges appear much darker and chitinous. Long, transparent, lanceolate companion setae (fig. 6) alternate with these spikes and extend to or slightly past the distal tips of the latter. These setae are often broken off and frayed distally, especially in the area of the anterior spikes, and they may appear to be broadly forked, or even tufted. These setae are very difficult to discern, and at first they appear to be part of the structure of the spikes themselves. Three posteriorly directed, very fine capillaries lie just dorsad of the major spike series, and a small tuft of five bilimbate neuropodial setae is present just anterior and ventral to the series.

The fifth segment is sharply raised on either side of the median depressed dorsal groove, which disappears by the seventeenth somite as the entire dorsum of the animal becomes raised and expanded. The posterior border of the fifth overlaps part of segment 6 and the musculature of these two somites is interconnected.

Parapodia. The first parapodium has only a ventral fascicle of well developed setae (although this has moved dorsally and is almost in line with the following notopodial fascicles, as is typical of the genus), and the neuropodial lobe is prominent and fused with the peristomium beneath the overhanging flaring lip of the lateral cephalic lobe, forming a continuous webbing. Notopodial lobes are present, but they bear no setae.

The postsetal notopodial lobes of setigers 2, 3, and 4 are well developed and extend dorsally and posteriorly to overlap the presetal lobe of the following parapodium. Parapodial lobes are absent on the fifth and sixth segments, but are present for some distance thereafter at the posterior border of the base of the branchiae. It is not possible to determine at what point they disappear, because of the condition of the specimen. The neuropodial postsetal lobes of the first four setigers are likewise highly developed and are almost as long as the corresponding notopodial lamellae. They are absent on the fifth and sixth setigers and thereafter are represented by highly reduced, fanlike lamellae arising just behind the simple hooded crotchets (the presetal lamellae are similarly developed in these segments, as can be seen in fig. 8).

From the second setiger to about the tenth, and excluding the fifth, which has a small tuft of three very fine capillaries, already described, the notopodia

bear very prominent fascicles of about 10 or 11 long, simple, limbate, yellow setae extending dorsoposteriorly in closely bound, discrete groups which overlap beyond the posterior borders of the following somite. These setae appear to be of two sizes and consist of smaller anterior setae which grade sharply into the longer posterior ones, the latter attaining more than twice the length of the former. From about somite 10, these setae diminish in size and number and come to point directly upward in a thin fine brush until the last few preanal segments, where they are replaced by from two to five longer, very fine, and slightly serrated (visible only under higher magnification), simple capillaries in each segment (fig. 8). The ventral fascicles on segments 1 through 6 all consist of simple pennoned setae.

Simple neuropodial hooded hooks or crotchets (figs. 3, 4, and 5) begin abruptly on the seventh segment and extend through about 79 or 80 somites in a single series per segment, all the way to the pygidium. The first two such crotcheted segments contain seven hooks each, the next two have nine, and the two following those, 10 each. From thence (segment 13) until about segment 56, they vary in number from between 7 or 8 to 11 per row, but average 9. From about 56 onward, they increase over three or four somites to 17 per row and fluctuate between 13 and 17 until the last two preanal segments, which have 11 or 12 each. To my knowledge, 17 is the highest number of hooded hooks per series for any species of *Polydora* (in the strict sense).

These crotchets are extremely long and slender, with a long beak forming an acute angle back against the main shaft and a shorter accessory or apical tooth forming a similar angle with the beak; both are covered by a closely fitting, transparent hood. As noted, these hooks lie in a single series on each segment, forming a fanshaped row, and the postsetal and presetal lamellae, which are considerably reduced, extend in an arc the length of the line of crotchets. The shafts are extremely long and somewhat sinusoidal, with a slight swelling which narrows into a "waist" at about the distal third of their length. These hooks are easily removed from the tissues of the animal, where they normally lie with just their distal tips exposed, and they tend to fall out of the tissues upon handling.

Branchiae. The branchiae are first present on segment 7. They are reduced on that segment, but by the following somite are fully developed into flat, wide, straplike structures which are about as wide as the segment is long. They become somewhat longer, narrower, and more cirriform posteriorly. They tend to be erect for a short distance and then curl inwardly over the dorsum, just matching their respective segments, making them difficult to discern. They do not meet in the middle and they dwindle in size far posteriorly; the last 25 or so segments are abranchiate.

Pygidium. The caudal region tapers sharply over the last seven or so seg-

ments. The pygidium (fig. 8) is wider than the last preanal segment and its "lips" are broadly flared and form a thick marginal roll. It is extended ventrally to over twice its dorsal length, which barely protrudes beyond the last setiger. It is dorsally notched.

Discussion. *Polydora narica* shows some superficial resemblances to *P. rickettsi* Woodwick (1961, pp. 78–81, figs. 1–7) in the prolongation of the prostomial caruncle to the anterior border of the fifth setiger, in the anterior prolongation of the prostomium, which in both greatly resembles that of *Boccardia proboscidea* (see above), and in the dark prostomial stripe. It is significantly different from *P. rickettsi*, however, in that the prostomial stripe extends onto the anterior margin of the prostomium, which is also slightly notched (unlike the condition in *P. rickettsi*), and the caruncle is greatly expanded dorsally and laterally into a prominent boss. Both the notopodial and the neuropodial postsetal lamellae of the anterior segments are better developed than in *P. rickettsi*. The dorsal capillaries of the fifth somite are oriented posteriorly (fig. 2), rather than anteriorly, and the fifth segment itself is considerably shorter and less developed than in Woodwick's species.

The spines or spikes have a pronounced flange, which is rudimentary in *P. rickettsi*. The companion setae are lanceolate, not plumose, and they are proportionately much larger. The sooty pigmentation is much more extensive, much like that of some specimens of *P. ciliata*. The branchiae do not extend as far posteriorly as in *P. rickettsi* and they are much longer and wider.

The well developed hoodlike flange of the modified fifth segment spines closely resembles that of *P. colonia* (see above) and to a lesser extent, that of *P. giardi* Mesnil (1896) and *P. ciliata*. As in *P. colonia*, this flange seems to terminate in a free margin on the posterior side of the main shaft just prior to reaching the lateral accessory tooth. Day (1961) reports that specimens of *P. giardi* from South Africa also possess an encircling flange (text fig. 5-k, p. 492), and not merely the simple accessory tooth previously noted (Mesnil, 1896, p. 198, pl. XII, figs. 8a, 8b, and 11; Hartman, 1941, p. 309, pl. 48, fig. 43). *Polydora ciliata* from various parts of the world has been reported by many authors to possess a similar semifalcate spike with a smaller accessory tooth in the concave region, but there is no associated flange. There are but three (rarely four) such spines in *P. colonia*, whereas there are five adult and four embryonic spines in *P. narica*, a condition similar to that of *P. ciliata*. They lie in a strictly vertical line in *P. colonia*, but form a steeply sloping arc in *P. narica*. The companion setae are similar in both.

Polydora narica has the largest number of neuropodial hooded crotchets of any known species of its genus, with up to 17 per row. This number is closely approached, however, in *P. cavitensis* Pillai (1965, p. 154), which bears from 10 to 16 such hooded hooks per ramus. The angle formed by the beak back

against the main shaft is acute in *P. narica*, rather than oblique as in *P. rickettsi* or *P. giardi*, and in this feature the hooks strongly resemble those of *P. colonia*, *P. cavitensis*, and *P. ciliata*. In all four, there is also a slight swelling along the main shaft which narrows into a waistlike constriction, but in *P. colonia* the transparent hood is separated into two well defined guards, whereas it is entire in the other three species. *Polydora narica* may be further distinguished from *P. colonia* in that the latter has but three to five crotchets per row and possesses single, heavy, hooked spines in the last seven or so notopodia (Hartman, 1945, p. 32). It is separated from *P. cavitensis* by the modified fifth setiger spines, which in the latter species have a simple, falcate, distal end with a deep subterminal notch; there is no accessory tooth or flange in *P. cavitensis*. *Polydora ciliata* normally bears seven to nine hooded hooks in a series (Mesnil, 1896, p. 216; Söderström, 1920, p. 262). Pacific animals, however, bear but four or five (Berkeley and Berkeley, 1936, p. 472).

The extreme number of crotchets in *Polydora narica* and *P. cavitensis* is intermediate between that of most species of *Polydora* and that of *Pseudopolydora antennata* Claparède (1870) and *Pseudopolydora kempi* (Southern, 1921 [see below]), in which they range up to 30 per row. Members of the latter genus, however, are all characterized by a U-shaped arc of modified setae in the fifth setiger, and in the crotchets beginning on the eighth, rather than the seventh, segment.

Although the modified fifth spines of *Polydora narica* most nearly resemble those of *P. colonia*, the presence in the latter of heavy, falcate, notopodial spines in the posterior segments places it clearly in the *P. hoplura* complex.[2] *Polydora narica*, therefore, appears to be closely aligned with *P. ciliata* and its allies, which possess the lateral tooth, but not the cowllike flange of *P. narica*—however, the adult spines of *P. ciliata* are very much like the embryonic spines of *P. narica*. The crotchets are very similar in both *Polydora ciliata* and *P. narica* except that in the latter, the swelling and associated constriction of the shaft occurs further medially, about one-third of the way down the shaft. The pigmentation is precisely like that of some specimens of *P. ciliata*, but the caruncle is longer posteriorly (this structure rarely goes beyond the middle of the second or the anterior border of the third setiger in *P. ciliata*). Unlike the latter species, the caudal region of *P. narica* is sharply tapered and the pygidium is much less prominent.

The presence of an extrusible papillated proboscis is noteworthy and indicates a generalized condition, since the tendency has been for members of this genus to lose this structure as they became more specialized for boring and tentacular feeding (Dales, 1967, p. 71). In this regard, Pettibone (1954, p. 281) reports that *Polydora caulleryi* Mesnil, 1897 (= *P. brachycephala* Hartman,

[2] *Polydora hoplura* Claparède, 1870.

TABLE 1. *A comparison of* Polydora narica *with other species of the genus.*

Species	*Prostomium*	*Caruncle*	*Branchiae*	*No. hooks per row*	*Angle of beak/shaft*	*Spines of fifth*	*Companion setae*	*Notosetae on 1.*	*Eversible proboscis*
P. narica	faintly notched; lateral stripe	to 5th; large boss	7th–25th last; well developed, straplike	7–17	acute; w/ swelling; shafts long	cowl-like flange; accessory tooth	lanceolate, transparent	absent	present; papillated
P. ciliata	weakly bifid; sometimes w/ lateral stripe	to mid-2 or 3	7th–10th last; well developed	3–9; average 8	acute; w/ swelling	falcate; w/ accessory tooth	lanceolate	absent	absent
P. giardi	distinctly bifid	to mid-4	10th–25th	3; rarely 4	oblique; no swelling	accessory tooth; (w/ flange in South Africa)	?	present	absent
P. rickettsi	rounded; lateral stripe	to 5th	from 7th; reduced	7	oblique	accessory tooth; rudimentary flange	plumose	absent	absent
P. colonia	rounded or entire to barely notched	to 4th	7–8th to 27th	3–5; rarely 6	acute; w/ swelling; "guards"	accessory tooth; cowl-like flange	lanceolate	present	absent
P. cavitensis	notched	to end of 3	7th–end	10–16	90° or acute; w/swelling; shafts long	simple; w/ distal notch	lanceolate	absent	absent
P. caulleryi	barely notched to distinctly bifid	to 4th or 6th	7–8 through many segments; reduced; absent posteriorly	2–3	oblique; subequal tips	2 kinds; falcate and pectinate	———	present	present; lobulated

1936) also has a "protrusible, somewhat lobulated, brownish proboscidial region." A specimen of *P. caulleryi* in the collection of the California Academy of Sciences shows this proboscis partially everted, but it is not nearly as well developed as in *P. narica*, in which it is at least as long as the length of the prostomium (fig. 1). *Pseudopolydora kempi californica* (see below) also exhibits a balloonlike proboscis, but neither this form nor *Polydora caulleryi* shows any evidence of papillae or other proboscidial organs.

Among the species of *Polydora*, several major groups are readily apparent, including an "*armata–caulleryi*"[3] group, a "*hoplura–colonia*" category, already mentioned, and a large "*ciliata–websteri–giardi*" complex[4] to which must be added such forms as *P. rickettsi*. *Polydora narica*, as we have seen, is clearly allied with *P. ciliata* and its relatives, but because of its proboscis and the close similarity of its fifth setiger spines with those of *P. colonia*, one is inclined to suspect that it may represent a link with the "*armata–caulleryi*" and the "*hamata–hoplura–colonia*" complexes, as well. In its proboscis and number of crotchets, it also shows affinities with the species of the more generalized genus *Pseudopolydora*. At the very least, we see in *Polydora narica* a very generalized member of the diverse and cosmopolitan "*ciliata*" group.

A comparison of the salient characters of some of the species discussed above is given in table 1.

TYPE MATERIAL. The holotype has been deposited at the California Academy of Sciences, Department of Invertebrate Zoology, as type number 380 and the spines of the fifth segment and crotchets from a posterior somite have been mounted separately on CAS slide numbers 351 and 352.

DISTRIBUTION. *Polydora narica* is known only from a single specimen collected August, 1962, off San Jose Creek Beach, Carmel, Monterey County, California, at a depth of between 100 and 200 feet in the Monterey Canyon in association with an ampharetid.

Genus **Pseudopolydora** Czerniavsky, 1881

Pseudopolydora kempi (Southern, 1921)

Pseudopolydora kempi californica Light, new subspecies.

(Figures 9–13.)

DIAGNOSIS. Prostomial caruncle prolonged posteriorly to the level of the middle of setiger 3; first two setigers crowded dorsally by the caruncle, and ventrally by the peristomium. No occipital tentacle. A balloonlike, eversible proboscis, with minute surface granules but no other processes. A dark lateral

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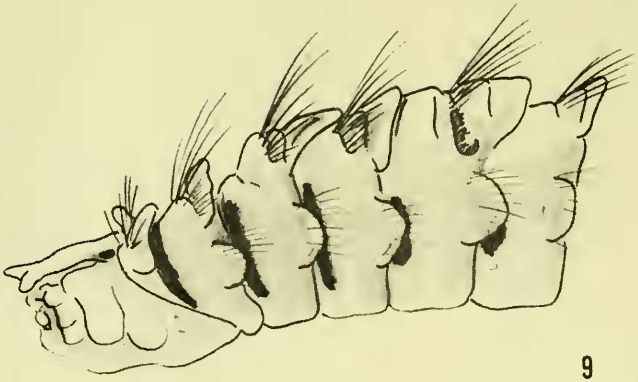
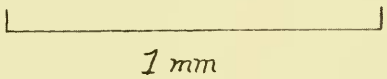
[3] *Polydora armata* Langerhans, 1880. *P. caulleryi* has a conical bundle of awl-shaped notosetae in the posterior segments, as does *P. armata*, and the fifth setiger spines of the two species also show affinities (Hartman, 1951, pp. 83–84).

[4] *Polydora websteri* Hartman, 1943.





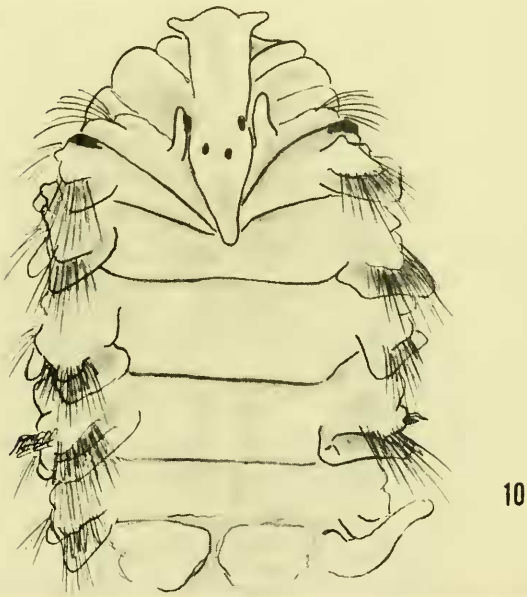


Figure 9. *Pseudopolydora kempi californica,* new subspecies. Anterior end, left lateral view, palpi removed. × 50.

Figure 10. *Pseudopolydora kempi californica,* new subspecies. Dorsal view, palpi removed. × 50.

stripe on the anterior borders of the first five or six setigers. Nine to 18 hooded crotchets in neuropodia, beginning on the eighth setiger. Pygidium well developed dorsally, with a deep notch; two cirriform processes on each side of this notch from the ventral surface of the dorsal lobe. No ventral development of the anal cup. In all other respects like *Pseudopolydora kempi kempi* (Southern).

Description. This subspecies conforms very closely with that described by Southern from Calcutta, India (1921, pp. 636–638, plate XXVII, figs. 20a–j) in all but a few respects. The prostomium is bifid and forms a T-shaped structure anteriorly, but there is a tendency toward the development of a median forward-projecting lobe. There are from four to six eyes arranged in two converging lines posteriorly back to the level of insertion of the palpi. The prostomial caruncle in all three specimens is prolonged posteriorly to the level of the middle of setiger three, but the first two setigerous segments are crowded both dorsally and ventrally along with the median anterior border of segment three, so that the caruncle, above, and the peristomium, below, actually terminate at the anterior edge of the third setiger (figs. 9 and 10). There is no trace of an occipital cirrus, which distinguishes it from all other forms of this species.

The holotype has a balloonlike, everted proboscis which is finely granulated, but there are no proboscidial organs of any sort.

A dark, vertical, black stripe runs along the anterior borders of the first five or six setigers (fig. 9), from below the level of the neuropodial postsetal lamellae to the middle (or above) of the notopodial fascicles. On segments four to six this stripe may be quite reduced or absent.

The notosetae of the anterior setigers are arranged in three transverse rows, as in both *Pseudopolydora kempi kempi* and *P. kempi japonica* Imajima and Hartman (1964, p. 287; see also Okuda, 1937, pp. 233–236). The anterior row consists of short, spear-shaped, bilimbate setae, the middle row contains somewhat longer unilimbate or "winged" setae and the posterior group is comprised of much longer, simple capillaries, or very faintly unilimbate setae. There are no notosetae on the first setiger, although the notopodial lobes are very well developed into erect digitiform processes.

The modified fifth segment is typical of both the genus and the species and contains two horseshoe or J-shaped rows of modified inferior dorsal setae which do not quite merge with the superior notosetal rows just described (fig. 9). These modified setae are as described by Southern and Okuda (see above) and they fall within the range for the stem subspecies (12 to 14 simple posterior spines and 13 to 15 anterior winged setae). The neuropodial postsetal lamellae are well developed in the anterior segments, but disappear with the advent of the neuropodial hooded hooks by segment 8. These crotchets range from 7 or 8 up to 18 per row, but they average 12 to 14. Only one specimen (paratype 378) had as many as 18 crotchets in a single ramus. The first several rows gen-

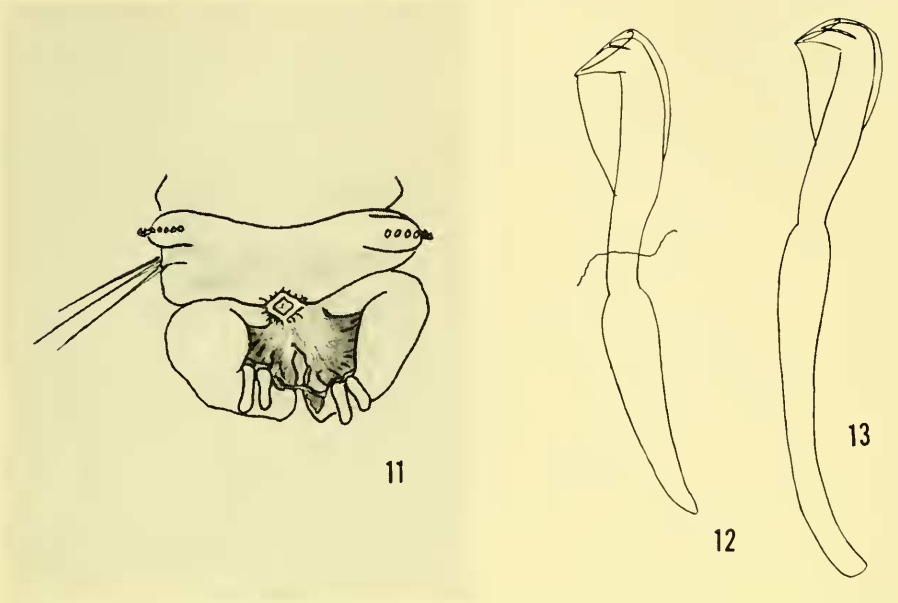


Figure 11. *Pseudopolydora kempi californica*, new subspecies. Pygidium, ventral view, showing digitiform processes. × 50.

Figure 12. *Pseudopolydora kempi californica*, new subspecies. Hooded neuropodial crotchet from fourteenth setiger. × 500.

Figure 13. *Pseudopolydora kempi californica*, new subspecies. Same, from setiger twenty-five. × 500.

erally contain fewer crotchets, averaging from 9 to 11. As in the other two forms, the fifth segment is the least modified of any species of *Pseudopolydora* and may not be easily distinguished from the adjacent segments when viewed from above.

From about the seventeenth somite, the segments become longer and rounder in cross section, until they are as long as they are broad. They are expanded in the middle and have a distinct barrellike appearance. Paired dorsal glandular swellings are present on segments six to 13, but the last pair is rudimentary.

Branchiae are present from the seventh segment and are continued over 14 to 18 segments; the last few pairs are reduced.

The crotchets have essentially the same configuration as in both *Pseudopolydora k. kempi* and *P. k. japonica*, but the stems of those of the posterior segments are longer than those of the more anterior somites (figs. 12 and 13). The apical tooth is closely applied to the beak and both form approximately a right angle to the shaft. The swelling and associated constriction occur at least halfway or more down the shaft, which emerges from the parapodial tissues at

a point slightly distal to this region. Posteriorly, the notosetae form long bundles of fine capillaries.

The pygidium is unique and consists of a well developed, flaring, dorsal hood which is deeply notched and which bears two fingerlike processes on either side of this notch on the ventral surface (fig. 11), somewhat mesad of the rim of the hood. The pygidium is completely suppressed ventrally and the anus opens directly to the exterior from the pre-pygidial segment. This pygidium is only present on the holotype (the other two specimens having lost their posterior ends) and at once distinguishes this form from the Japanese variety.

Discussion. *Pseudopolydora kempi californica* is more closely related to the Indian than to the Japanese variety. In the smaller number of modified setae of the fifth setiger, *P. k. kempi* and *P. k. californica* are separable from the Japanese race, which bears from 23 to 27 such setae. The number of crotchets in the California specimens varies from about 8 to 18, but averages 12 to 14, whereas *P. k. kempi* has from 18 to 20 of these hooks. *Pseudopolydora kempi japonica* bears from 25 to 28 in each ramus, a condition approaching that of *P. antennata* (see above). The number of branchiae (14 to 18) is intermediate between that of the Indian (10 to 12) and the Japanese varieties (18 to 24). Both of the Oriental forms possess a more or less well developed occipital cirrus, which is completely lacking in the California examples.

The pigmentation (see above) differs from that of *P. k. kempi* in that each of the anterior segments of the latter bears a single transverse line of black spots on the dorsum, which may be reduced to two median spots. No color pattern has been given for *P. k. japonica.*

The Japanese form is much longer than the other two, attaining a length of 28 mm. for 48 segments. The California variety is about the same size as the stem subspecies and the holotype measures 6.5 mm. over 26 setigers, as compared with 6.5 mm. over 27 setigerous segments for the Calcutta animals. The two larger specimens of the California population measure 9 mm. over 32 segments (paratype 378) and 9 mm. over 30 segments (paratype 379). The last two animals are about 1 mm. wide at their broadest point.

The pygidium is distinct from the Japanese form, and, indeed, is unique among the polydorids in its configuration. In *P. k. japonica,* the pygidial cup is well developed ventrally and there is only one cirriform process on either side of the dorsal notch, arising at the edge of the lobe. The posterior region of the stem subspecies remains unknown.

Table 2 compares the main features of the known varieties of *Pseudopolydora kempi* with *P. antennata.*

Habitat. Both *P. k. kempi* and *P. k. californica* have been recovered from brackish, estuarine waters, but the former seems to be tolerant of nearly freshwater conditions. It was collected in a canal at Chingrighatta near Calcutta,

TABLE 2. *A comparison of the known subspecies of* Pseudopolydora kempi *with* Pseudopolydora antennata.

Species	*Caruncle*	*Nuchal cirrus*	*Branchiae*	*No. hooks per row*	*Pigment*	*Pygidium*	*No. modified setae on 5*	*Constriction of hooks*
Ps. kempi kempi	no prolongation	present	10–12	18–20	dorsal spots	unknown	12–15	at midpoint of shaft or lower
Ps. kempi japonica	to 4th	present	18–24	25–28	unknown	well developed; a process on each side of dorsal notch	23–27	at midpoint of shaft
Ps. kempi californica	to middle of 3rd	absent	14–18	8–18; average 12–14	lateral stripes	dorsally developed; suppressed ventrally; two processes on each side of notch	12–15	at midpoint of shaft or lower; posterior hooks longer
Ps. antennata	to 5th or 6th	present	from 7th over 40–50 segments, nearly to end	25 to more than 30	lacking	well developed; notched dorsally and ventrally	14–16	in distal third

where the water had a corrected specific gravity of 1.004 (Southern, 1921, p. 638). This corresponds to a salinity of 6.3 parts per thousand. The Japanese forms appear to have been taken primarily from marine waters, although they have also been collected from inland waters on the Korean Archipelago (Taisei, Quelpart Island). The salinities were not recorded for the north end of Bolinas Lagoon at the time the California specimens were collected (August, 1967), but readings of 31.9 and 31.5‰ were obtained in November of the same year for nearby stations. Bolinas Lagoon is subject to great fluctuations in this regard and the following December produced readings of 14.5 (at the bottom) and 22.2‰. The Morro Bay specimens were collected from marine conditions, but they are in all likelihood subject to decreased chlorinity during the winter (Reish and Barnard, 1967, p. 4).

One cannot tell from these data what the lower limits might be for this organism, but only that it came from an environment that is subject to drastic changes in salinity.

Pseudopolydora kempi californica was taken from a mud bottom in association with the following polychaetes:

SPIONIDAE:

Boccardia proboscidea Hartman (1940)
Boccardia truncata Hartman (1936)
Boccardia hamata (Webster, 1879) = *B. uncata* Edith Berkeley (1927)
Polydora ligni Webster (1879)
Polydora species
Streblospio benedicti Webster (1879)

CAPITELLIDAE:

Capitella capitata (Fabricius, 1780)
Heteromastus cf. *filiformis* (Claparède, 1864)
Notomastus tenuis Moore (1909)

CIRRATULIDAE:

Tharyx parvus Berkeley (1929)

The following amphipod crustaceans were also collected at these stations: *Ampelisca* species, *Ampithoë* species, *Corophium insidiosum* Crawford (1937), and *Corophium* species. A brachyuran, *Hemigrapsus oregonensis* (Dana, 1851), was taken at two of the stations, and the following mollusks, *Cryptomya californica* Conrad (1837), *Gemma gemma* Totten (1834) and *Cerithidea californica* Haldeman (1840), were also reported.

TYPE MATERIAL. The holotype and two paratypes were deposited at the California Academy of Sciences, Department of Invertebrate Zoology, as type numbers 377, 378, and 379; the major spines of the fifth setiger and parapodial structures of anterior, median, and posterior somites have been mounted separately as CAS slide numbers 347, 348, 349, and 350.

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